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Phasespace transport of heliospheric pick-up ions under the controle of CGL invariants

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The phasespace transport of heliospheric pick-up ions is studied from the time of their injection into the solar wind bulk onwards. We consider the combined effects of two different processes, velocity drifts parallel and perpendicular to the local magnetic fields and velocity space diffusion due to nonlinear ion interactions with magnetoacoustic turbulences. The resulting velocity drifts are shown to be enforced due to two magnetic particle invariants which need to be conserved and macroscopically are connected with the well known CGL invariants. At larger solar distances and in the energy range below 1 KeV these effects are dominant and enforce velocity power-laws with the spectral index (-5). At higher energies the ion spectrum is determined by nonlinear wave-particle interactions with magnetoacoustic turbulences also leading at larger distances to a velocity space diffusion again enforcing a power-law spectral distribution with the index (-5). This shows that at large solar distances unbroken power-laws can be expected for pick-up ions all the way up from 0.1 to 50 KeV. We calculate the pick-up ion pressure from these power-laws and can show that the solar wind deceleration due to pick-up ion loading is partly compensated by the action of the gradient of this pressure.